

Serial No. 10/518,491
Amendment
Responsive to Office Action dated February 2, 2007

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IN THE CLAIMS

This listing of the claims will replace all prior versions and listings of claim in the present application.

Listing of Claims

1. (Currently Amended) A control device of a high-pressure fuel pump of an internal combustion engine having a pressure chamber into which fuel flows through an inlet valve, is pumped under high-pressure and then discharged through a discharge valve, comprising:
a control unit that sends a drive signal having a start phase and an end phase to an actuator for operating said inlet fuel valve to cut off fuel flow to said pressure chamber,
means for calculating the end phase of the drive signal with respect to a first predetermined phase, and
said end phase calculating means setting the end phase as the calculated end phase when the calculated end phase is on an advanced side of the first predetermined phase, and setting the first predetermined phase as the end phase when the calculated end phase is on a delayed side of the first predetermined phase - having a fuel injection valve provided on a cylinder and the high pressure fuel pump for pumping fuel to said fuel injection valve,
characterized in that
said high pressure fuel pump comprises:
a pressure chamber;
a plunger for pressurizing the fuel in said pressure chamber;
a fuel valve provided in said pressure chamber; and
an actuator for operating said fuel valve, and characterized in that wherein

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~~said control device has means for calculating a drive signal of said actuator so as to realize the variable discharge of said high pressure fuel pump, and that means for calculating said drive signal has means for limiting end timing of the drive signal of said actuator to a predetermined phase.~~

2. (Currently Amended) The control device of a high pressure fuel pump of an internal combustion engine according to Claim 1, characterized in that wherein said first means for limiting to said predetermined phase limits end timing of a drive signal of said actuator is set to be prior to the top dead center of said plunger.

3. (Currently Amended) The control device of a high pressure fuel pump of an internal combustion engine according to Claim 1, characterized in that wherein said means for calculating an end phase of the drive signal the means for limiting to said predetermined phase calculates the end timing of a an end phase of the drive signal of said actuator through the use of at least one of a number of revolutions of the engine, injection fuel quantity injected from said fuel injection valve, battery voltage and coil resistance.

4. (Currently Amended) The control device of a high pressure fuel pump of an internal combustion engine according to Claim 1, characterized in that the means for limiting to said predetermined phase wherein said means for calculating an end phase of the drive signal is an electronic circuit.

5. (Currently Amended) The control device of a high pressure fuel pump of an internal combustion engine according to Claim 1, characterized in that when the end timing of a drive

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signal of said actuator is limited to said predetermined phase, wherein at least one of a fuel injection quantity injected from said fuel injection valve, fuel injection timing and ignition timing is changed and controlled to change when a calculated end phase is on the delayed side of the first predetermined phase.

6. (Canceled)

7. (Canceled)

8. (Currently Amended) ~~A~~The control device according to claim 1, wherein of a high-pressure fuel pump of a direct injection internal combustion engine having a fuel injection valve provided on a cylinder and a high pressure fuel pump for pumping fuel to said fuel injection valve, characterized in that

— said high pressure fuel pump comprises:
— a pressure chamber;
— a plunger for pressurizing the fuel in said pressure chamber;
— a fuel valve provided in said pressure chamber; and
— an actuator for operating said fuel valve, and characterized in that
— said control device has means for calculating a drive signal of said actuator so as to realize the variable discharge of said high-pressure fuel pump, and that the means for calculating said drive signal has means for limiting the output timing of a drive signal of said actuator to be within a predetermined phase range

said control unit comprises means for calculating the start phase of the drive signal to the actuator with respect to a second predetermined phase, said means for calculating the start

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phase of the drive signal setting the calculated start phase as the start phase when the calculated start phase is on a delayed side of the second predetermined phase and setting the second predetermined phase as the start phase when the calculated start phase is on the advanced side of the second predetermined phase.

9. (Currently Amended) The control device of a high-pressure fuel pump of a direct injection internal combustion engine according to Claim 8, characterized in that the means for limiting to be within wherein said second predetermined phase range limits output timing of a drive signal of said actuator to is set at a point of time whereat we went back to the past from the before bottom dead center of said plunger by a time period corresponding to equal to the operation of said actuator operating time period, and/or thereafter.

10. (Currently Amended) The control device of a high-pressure fuel pump of a direct injection internal combustion engine according to Claim 8, characterized in that the means for limiting to be within said predetermined phase range limits the output timing of a drive signal of said actuator to be within a point of time whereat said plunger arrives at the top dead center wherein said means for calculating a start phase of the drive signal limits said start phase of the drive signal to the actuator to be on the advanced side before the top dead center of said plunger.

11. (Currently Amended) The control device of a high-pressure fuel pump of a direct injection internal combustion engine according to Claim 8, characterized in that the means for limiting to be within said predetermined phase range limits the output timing of a drive signal of said actuator to be while said plunger arrives at the top dead center from the bottom dead

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~~center, and prior to the bottom dead center of said plunger and within an operating time period of said actuator wherein said means for calculating a start phase of the drive signal limits said start phase of a drive signal to an actuator to be a point of time before bottom dead center of said plunger by a time period equal to the operation of said actuator or thereafter, and prior to the top dead center of said plunger.~~

12. (Currently Amended) The control device ~~of a high pressure fuel pump of a direct injection internal combustion engine according to claim 11, characterized in that~~ wherein ~~the~~ said means for calculating a start phase of the drive signal includes ~~of~~ said actuator has means for operating a reference angle of said actuator on the basis of a basic angle of said actuator, target fuel pressure and actual fuel pressure, and means for correcting an working delay of the actuator, and calculates ~~operation starting time of~~ said actuator on the basis of ~~these output signals~~.

13. (Currently Amended) The control device ~~of a high pressure fuel pump of a direct injection internal combustion engine according to Claim 12, characterized in that~~ wherein ~~the~~ said means for limiting to be within said predetermined phase range limits ~~an~~ calculating a start phase of the drive signal operates on the basis of output signals from the means for operating a reference angle of said actuator.

14. (Currently Amended) The control device ~~of a high pressure fuel pump of a direct injection internal combustion engine according to Claim 12, characterized in that~~ wherein ~~the~~ said means for limiting to be within said predetermined phase range limits calculating a start phase of the drive signal operates on the basis of output signals from the means for

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operating a reference angle of said actuator and the means for correcting working delay of
saidthe actuator.

15. (Currently Amended) The control device of a high-pressure fuel pump of a direct injection internal combustion engine according to Claim 13, characterized in thatwherein the said means for calculating a start phase of the drive signal and said means for calculating an end phase of the drive signal retrieves said first and second predetermined limit~~ing~~ to be within said predetermined phase range retrieves said phases range in response to an operating state of thesaid internal combustion engine.

16. (Currently Amended) The control device of a high-pressure fuel pump of a direct injection internal combustion engine according to Claim 12, characterized in thatwherein thesaid means for limiting to be within said predetermined phase range limits an amount of feedback control to be calculating a start phase of the drive signal and said means for calculating an end phase of the drive signal operate on the basis of a feedback control quantity calculated from a difference between said actual fuel pressure and said target fuel pressure.

17. (Currently Amended) The control device of a high-pressure fuel pump of a direct injection internal combustion engine according to Claim 12, characterized in thatwherein the means for limiting to be within said predetermined phase range limits an amount calculating a start phase of the drive signal and said means for calculating an end phase of the drive signal operate on the basis of a control quantity for causing said an actual fuel pressure to coincide with reach said target fuel pressure.

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18. (Canceled)

19. (Currently Amended) The control device of a high-pressure fuel pump of a direct injection internal combustion engine according to Claim 1, characterized in that wherein said means for calculating a drive signal of said actuator makes the width start phase of the drive signal and said means for calculating an end phase of the drive signal make said start and end phases of the drive signal of said the actuator variable by according to the a number of revolutions of the internal combustion engine and/or or/and the battery voltage.

20. (Currently Amended) The control device of a high-pressure fuel pump of a direct injection internal combustion engine according to Claim 1, characterized in that when said control device compares actual fuel pressure with target fuel pressure, the pressure difference exceeds a predetermined value, and continues for a predetermined time period or longer, the control device prohibits said high-pressure fuel pump from pressurizing wherein said high-pressure fuel pump is prohibited from pumping up, when the pressure difference, as a result of comparison by said control device of actual fuel pressure with target fuel pressure, exceeds a predetermined value and continues longer than a predetermined period.

21. (Currently Amended) The control device of a high-pressure fuel pump of a direct injection internal combustion engine according to Claim 1, characterized in that when said control device compares the actual fuel pressure with the target fuel pressure, the pressure difference exceeds a predetermined value and the actual fuel pressure is lower than the target fuel pressure, said control device causes wherein said high-pressure fuel pump is caused to

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discharge ~~the-a whole amount of fuel of the pressure chamber when the pressure difference,~~
~~as a result of comparison by said control device of actual fuel pressure with target fuel~~
~~pressure, exceeds a predetermined value, and said actual fuel pressure is lower than said~~
~~target fuel pressure.~~

22. (Currently Amended) The control device ~~of a high-pressure fuel pump of a direct~~
~~injection internal combustion engine according to Claim 1, characterized in that when said~~
~~control device compares the actual fuel pressure with the target fuel pressure, the pressure~~
~~difference exceeds a predetermined value and the actual fuel pressure is higher than the target~~
~~fuel pressure, wherein said control device prohibits said high-pressure fuel pump from~~
~~pressurizing pumping-up, when the pressure difference, as a result of comparison by said~~
~~control device of actual fuel pressure with target fuel pressure, exceeds a predetermined~~
~~value, and said actual fuel pressure is higher than said target fuel pressure.~~

23. (Currently Amended) The control device ~~direct injection internal combustion~~
~~engine according to Claim 22, characterized in that wherein said predetermined value or said~~
~~predetermined time period is retrieved in response to an the operating state of the internal~~
~~combustion engine.~~